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ABSTRACT

After using the "Physics: A Human Endeavor" curriculum for a period of time students and teachers in the Canadian provinces of Newfoundland and Labrador, in general, suggested that there was a need for a curriculum change. This paper reports on ways to effectively change the curriculum. Topics included are: (1) need for change in the physics curriculum; (2) history of the committee for the curriculum change; (3) change and development model; (4) curriculum change as an educational change process (including societal influences, evaluation prototypes, change models; and (5) summary. Appendices include a report on the high school physics program by the NTA Science Council, summaries of two teleconferences of physics teachers, letters, and a summary of the education system. (YP)

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Issues in the Inducement of Curriculum Changes in Science (Physics) Instruction

by

Robert Joseph Kelsey

A Comprehensive Paper submitted in partial fulfillment of the requirements for the Degree of Master of Education St. Michael's College.

June 1988

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1. Introduction - Statement of Need

The foundation of this paper is based on the needs of high school Physics teachers in the province of Newfoundland and Labrador. The realization of this need initially came about from discussion among high school Physics teachers in Newfoundland and Labrador. The need expressed by these teachers was for a change in the Physics curriculum that was used at that time and is still being used. This program uses four of six modules of a program called Physics:A Human Endeavour (Douglas Paul, Denny Pierce and Kenneth Stief, 1976). The courses taught were Physics 2204: which consisted of Module I, Motion, and Module III, Energy and the Conservation Laws; and Physics 3204: containing Module IV, The Nature of Light and Sound and Module V, Electricity. This program followed the format of the Harvard Project Physics course, which is a course developed in the United States in the late 1950's in response to Sputnik.

This modularized program for Physics 2204 and 3204 has several problems. The concern for these problems indicated by Physics teachers, led to the interest in the process of curriculum change. The statement of need was also formulated from students who were surveyed in post secondary institutions as described in Appendix A.

When this text was initially introduced in 1976,

teachers felt that it was a satisfactory text. Many teachers liked the presentation. However, as can be seen in Appendix A from the evaluation of teachers responses to the questionnaire, teachers now feel that the program is unsatisfactory in meeting the needs of Physics students now, and in the future. This is further substantiated in Appendix B.

Areas that teachers found lacking in the program were the following:

1). All modules lacked sufficient practice problems. In some cases one example would be given in the text and one review problem. Teachers therefore had to spend a lot of time finding practice problems to supplement the text from other text sources. The time writing up these problems and duplicating them could have been better spent giving students with difficulties individual help or attention. Most teachers find Physics to be a course where the average student needs much drill and practice to fully appreciate and understand many of the complex theories involved, particularly in cases like Ohm's Law and how it relates to series and parallel circuits.

2). One of the more frustrating things teachers found was the irresponsibility of the publishers who continue to reprint the text and not correct things like:

a) Diagrams that were poorly illustrated.

b) Contradictory and confusing explanations or descriptions of concepts.

c) Incorrect solutions to problems in the back of the text.

3). Although the laboratory component of the modules emphasizes a hands-on approach and learning through discovery, students find the lab descriptions so confusing and the diagrams so poor that teachers have had to rewrite the directions in a step by step format in order for them to complete labs in the standard 40 minute period.

4). This program, Physics: A Human Endeavour, was introduced to Newfoundland in 1976. Until 1985 these modules had been used by teachers without the aid of a Teacher's Guide. In 1985 a Teachers' Solution Manual for Physics 2204 was introduced to assist new teachers in the teaching of the program. However, up until 1985 teachers were responsible for teaching these courses without these aids.

5). Provincial guidelines state that it is not necessary for students to complete Physics 2204 before entering Physics 3204. However, it is assumed that students doing Physics 3204 have an understanding of terms and concepts that would have been taught in Physics 2204. Therefore, the teacher has to spend extra

time teaching these concepts to students who had not completed Physics 2204.

6). The course does not include information on how the theories they learn may be applied to modern technology and society. It is important that the science-technology-society connection be made in Science courses to increase scientific literacy (Science Council of Canada, 1984). It is through this literacy that students can relate what is being done in the classroom to what is going on in the everyday world around them. The present text doesn't do this, so it is imperative that the teacher supplement their classes with discussion on these topics whenever possible. This is restricted by the course content that must be completed during a school year. However, it would be of great benefit if there were some extra reading material in the text that the teacher could assign and test it, along with the core program.

7). This Physics course does not include any information on how Canadians have contributed to science or how science has affected Canadian Society (S.C.C.,1984). This course deals with the work of the great scientists. It does not take that extra step and show how modern day scientists have taken that informaton and applied it to new technologies. The course should also discuss some of the history of modern

day scientists, particularly Canadians who have made numerous contributions to science, for example, the scientists involved with the Canadian arm on the space shuttles. Students find it easier to identify with modern scientists, whereas in comparing themselves to Newton, Galileo, etc., they would be turned off from science because they would feel inadequate in terms of the contributions these men have made to science in comparison with their own abilities. This leads to attitude problems that present themselves in this form " I can't do Physics after all I am no Einstein." from a student.

8). This Physics course does not mention any of the possible careers that may be related to Physics. One of the things students need at the senior level is exposure to applications of science as related to different career fields. In this way students can get information about the different types of careers in the science field.

9). The student text should be the same for both Physics 2204 and 3204. The modules are easily lost or thrown away. However, a good text book may be kept by the student as a reference. Some basic features of a good text would include the following: a) a broad Physics base, with practical labs and sample problems, b) well labelled diagrams, c) a match between the

reading level of the course and that of the average student in the class, d) a glossary of defined terms, e) a match must be made between the mathematical level of the text book and that of the average students in the course, f) there must be a match between the conceptual level of the Physics topics in the textbook and the average student's levels of development, g) Appendices on the Metric System, Derived units in Physics, Physical Constants, Trigonometry, Trignometric Tables, Graphing Scientific Data and other pertinent information should also be included. This would then be a book that the student could keep as a reference.

From the student perspective this course lacked in several areas. Some of these are:

1). The modular approach did not give students a strong reference, since it only dealt with information in that particular module, ie. Motion.

2). The modules did not have a glossary of terms in each book. This is a necessity in any introductory Science course.

3). There were several editing errors in the modules that confused the students, for example: opposite descriptions of step up and step down transformers in Module V Electricity.

4). Students found that the directions for experiments and activities were often written in a

format that they found difficult to understand and complete in alloted laboratory periods.

5). Several diagrams were inaccurately labelled and misleading. This led to assumptions by the students that confused and disturbed them.

6). Students found it very confusing to solve problems correctly and then find a wrong answer in their text. They then thought their answer was wrong or that the teacher had showed them the wrong way to solve the problem. This caused some lack of confidence in themselves and sometimes in their teacher.

7). The overall readability of the text was beyond the level of the high school student, particularly since there was no glossary of terms. Readability was determined from student response and teacher perception of students' ability to comprehend material read based on the results of questionnaires to both groups in Appendix A. In reference to readability, the Provincial Science Curriculum Committee in their (1976) report to the Department of Education Criteria for Evaluating Textbooks states: "The first constraint is that there must be a match between the reading level of the textbook and that of the average students in the course. The readability of a Physics book is a function of more than sentence and word length; hence it is difficult to do a pre-use evaluation of this constraint" (p. 7).

8). The most modern experiments in the laboratory component of this course date back to the early 1900's. Students are basically repeating the experiments of Galileo, Newton, Oersted and Faraday. The text does not give students examples of where the experiments might be used and they are not given the chance to take these theories and relate them to experiences in their daily lives.

These are things that one might expect in the first printing of the text. However, after the fifth reprinting, teachers expected these problems to be remedied, particularly, when you look at a publishing company with the reputation of Holt, Reinhart and Winston.

As a result of these perspectives on the present Physics curriculum, teachers were faced with the question, can they live with this Physics curriculum? The teachers answer was no, since they believed there had to be an alternate curriculum that did not have so many deficiencies. This led to an investigation of the process of the most effective way to change curriculum that will now be addressed in this paper.

2: Documentation of Need

The need for a change in the Physics program became more conspicuous in the fall of 1985. At this time the Annual General Meeting (A.G.M.) of the Newfoundland Teachers Association (N.T.A.) Science Council was held. The problems with the course, as discussed by the people present, were similar to those presented in the introduction of this paper and in the Appendices. The group was disgruntled with the present program. During the meeting, the teachers thought that some direction was needed with respect to their ideas of the present program. After a great deal of discussion, the group thought that the new Physics representative, who was to be elected to the N.T.A. Science Council, be given a mandate to make a report on the present High School Physics Program. There was a unanimous consensus of the group on this point. The only remaining business was to elect a new Physics representative, who would assume this task. The person elected was Cecil Lake from Corner Brook. He immediately established a committee consisting of himself and Robert Kelsey, of St. John's. The reason for the committee was because of geographical placement. One person could not survey adequately the educational centres involved. The report of this committee would be slated for presentation at the next N.T.A. Science Council A.G.M. The committee immediately

met and set out its objectives. The main objective was to see if an evaluative questionnaire would yield definite information concerning the present high school Physics program.

The next step in the process was to decide who would receive the questionnaire. It was obvious that the views of high school Physics teachers were necessary. It was the committee's view that it would be important to find out how students in the post secondary schools felt about how the high school Physics program prepared them for Physics at the University and other post secondary institutions. In addition, it was thought that the views of the instructors of these students in these institutions would be informative and helpful in identifying problem areas of the high school Physics course. It was to these groups of people that the questionnaires were sent. It was from their views that the committee of the Physics Branch of the N.T.A. Science Council made its report on the high school Physics program. This report can be found in Appendix A of this paper. It includes copies of teacher and student questionnaires. The paper was presented at the 1986 A.G.M. of the N.T.A. Science Council in Corner Brook. The recommendations of the paper may be found in Appendix A.

It was at this meeting in Corner Brook that the

Science Co-ordinator for the Department of Education in Newfoundland was given the report. His response was that the new Physics representative elected to the Science Council should make a proposal to the Director of Curriculum in the Department of Education. He continued to say that he would support the recommendation of that report in his capacity as Science Consultant. However, he suggested that a resolution be made by the Physics teachers present, to show their unanimous support of the committee report. This resolution was put forth and there was complete accord to support the report. It was noted that not all the Physics teachers in the province were present to demonstrate their support of the committees report. Professor Weir of Memorial University of Newfoundland (M.U.N.) Physics Department stated, that he was doing work on long distance education and that it would be possible to set up a teleconference on this topic. It was thought by those present at the meeting that this was a good idea. It would be important to the validity of the committee's report if all the teachers in the province were again given the opportunity to respond to the report via this new medium. The Science Consultant was then requested to participate in this teleconference so that he could hear first hand the opinions of Physics teachers. After this the only remaining thing to do was

to elect a new Physics representative to the N.T.A. Science Council. Robert Kelsey was elected and announced that he would use the Committee's Report as a mandate for the direction his work would involve for the next year.

On November 6, 1986 a teleconference was held using the facilities of M.U.N. throughout the province. Prior to this conference every high school Physics teacher in the province was sent the date, time of the conference, where to go to participate, directions on how to participate, an agenda and a questionnaire which was to be returned to the Physics Department of M.U.N.. The summary of this teleconference including a copy of the agenda and the Physics teacher teleconference participant questionnaire may be found in Appendix B. The overwhelming response of the teleconference was an 88% agreement that the Department of Education should set up a Physics Curriculum Committee to re-examine the whole course and evaluate alternate text material for possible piloting and future adoption.

The final step in the documentation of need in the inducement of change of science curriculum was an official request for an evaluation of the present high school Physics Curriculum. This request was made to the Director of Curriculum in the Department of Education that can be found in Appendix C. The response

(Appendix D) was that a change would be possible during the 1986-87 year. It stated that a Physics Committee would be established and begin work in the fall of 1987.

3. How to Best Change Science Curriculum (Physics)

In order for change to take place it is necessary to understand the educational system in which the change is to occur. From this point one can determine guidelines as to what approach to follow when change is desired. The description of the educational system where the process for change took place in this paper may be found in Appendix E. This Appendix discusses the role of government, the church and school boards.

An observer of the process of change would look at the events described to this point and question the direction it was following. The observer would now try to find some kind of framework or model in which to place the sequence of events so that one could clearly see the direction the process was following. In fact, there is a model (Figure 1) that was developed by the Department of Education. It was first described by Oakley (1976). During the time since 1976 this model has been modified, most recently by Harry Elliot, Science Consultant, Department of Education. It is necessary to discuss the model to see how it can best be used to change science (Physics) curriculum.

Figure 1. Curriculum Change and Development

The model starts with the identification of need for a change in curriculum. This may come from four (4) different sources:

1. The Department of Education through its consultants identifies an area where change is necessary. This need may arise from the results of Newfoundland students on the National Canadian Test of Basic Skills. These results may identify an area of need for example, reading level, which may be lower in Newfoundland than the Canadian average, therefore indicating some changes may be necessary in the reading programs.
2. School Districts may identify a need for change in curriculum in that we use Canadian and American text books. This may not relate to the needs of students living in Newfoundland. An example here would be a Science course that related entirely to a terrestrial environment, whereas in Newfoundland its culture and economic development is dependent on the marine environment.
3. N.T.A. Council may have identified a need for a change in curriculum as is discussed in the case of high school Physics in this paper.
4. Other (M.U.N.) identification of a need for change

from this source may result from research. Examples of how they identify need for change would come from Memorial University of Newfoundland (M.U.N.) in areas like: A Case Study of Science Curriculum in Canada where one of the three principal investigators was involved in research at M.U.N..

The identification of need has now been expressed and must now be documented through a proposal which is the method followed in Chapter Two of this paper. At this point the proposal has to be either accepted or rejected. If rejected, it can be modified and re-submitted. It then can be rejected and terminated or modified until accepted. If accepted, then a working group is established. It is at this point that we leave the Physics example discussed in Chapter Two because it is presently at that stage of the process. However, it is necessary to continue with our model to appreciate the direction and framework that is required in order to facilitate the process of change. The established working group develops a program. From the program the group reviews the available texts from publishers and selects those that may best express the needs of the program. Pilot text or texts are recommended and pilot teachers are identified and given inservice training for the new program. It is at this point in the process

that time becomes a major factor and the reason for this is that pilot courses can only be initiated at the commencement of the school year. The pilot is then evaluated for two years. This is because a Level II Physics 2204 and a Level III Physics 3204 are offered and students would be required to go through both stages in order to evaluate the program. This would entail a two year period. If the pilot is successful the program is accepted and a modified text is recommended. This would lead to inservicing of district science co ordinators by the Department of Education. These co-ordinators would then have an inservice for Physics teachers in it's district. The program would then be implemented in all schools throughout the province. Monitoring would continue with modification and additional inservice when necessary. It is through this process that a science (Physics) curriculum is changed in this province. This process is a time consuming event and one finds that it is only a period of time again when society has changed and programs need to be re-evaluated starting with our identification of need. To illustrate this Frymier (1969) stated: "Education is a social organization and every organization reflects two basic needs: the need to maintain and the need to improve. Schools are no exception to this rule' (p. 10). The improvement takes place through the process of

change in curriculum. Carlson (1965) states:

> Adoption of new educational practices is only one means by which school systems attempt to adjust to their environment. The educational enterprise also changes its structure, size and support; alters its definition of purpose or mission; and characteristics of its personnel. But, the adoption of new educational practices, practices which alter the instructional program, seems to be at the center of the issue as school systems attempt to provide an adequate education for their clients. (p. 10)

4: Fundamentals of Science Curriculum Change

The influence of society on change: Looking at change in a historical perspective, one can see that change in education takes place because of influences from society and technology. Miller (1967) states that:

> The "knowledge explosion" as much as any one single factor has been responsible for the present ferment in American education. There was a time when a scholar could encompass the whole of original knowledge. How different today! Coverage of a subject is not difficult it is impossible. (p. 6)

As societies developed educational change was put to the fore front with the launching of Sputnik. Brickell (1961) states that: "... after taking an inventory of instructional innovation in schools in New York State, indicated the rate of introduction of such innovations more than doubled within 15 months after the launching of Sputnik I in October, 1957" (p. 18). This cold war between the Soviet Union and the United States increased the demand for improvements in science, technology, and therefore education that lasted from the fifties to the sixties and even can be reflected today when looking at controversial topics like Reagan's "Star Wars" and the Soviet Union's "Space Station". For these to remain competitive educational change is imperative for the

continuation of each society.

In the 1970's and 1980's we see the influence of technology in educational change. This is evidenced in the New Educational Revolution in Future Shock. Toffler (1970) points out:

> It is no longer sufficient for Johnny to understand the past. It is not even enough for him to understand the present, for the here-and-now environment will soon vanish. Johnny must learn to anticipate directions and rate of change. He must, to put it technically learn to make repeated probalistic, increasingly long range assumptions about the future. And so must Johnny's teachers (p. 403)

Education has been forced to change because of challenges like those proposed by Toffler. In 1980 Toffler's Third Wave re-issued the challenge for educational change. In 1983, American society is exposed to "A Nation at Risk", a report that states the demands for educational reform have not been met or have not kept pace with society and technology. This point is illustrated by Hurd (1985) "Our nation's young people grow up as foreigners in their own culture and leave high school as scientific and technological illiterates" (p. 83). It is in response to these pressures that we

look to educational change to meet the needs of tomorrows world. In Canada similar questions are asked by the Science Council of Canada (1984):

> Tomorrows citizens and decision makers are in school today - are they receiving the education they will need in the 1990's and beyond? As the rate of change increases and the world becomes even more complex, Canadian students need more and better science education to prepare them for the future. (p.9)

Change as a result of Evaluation: In reading the literature on change, in curriculum, it is evident that change is brought about as a result of evaluation. In this paper physics curriculum change was brought about by teacher and student evaluation. In the literature one can find many models of curriculum evaluation. Although this paper's evaluation of the physics curriculum did not follow these models directly, it is necessary to point out that it is through evaluation that the documentation of need for curriculum change is realized. Until this need is identified, then change does not take place. Frymier (1969) reflects:

> Given the urgencies and the pace of the times the case for educational change is born. Change for the sake of change is not

> desirable, of course, but progress in a democracy develops out of the sensitive and intelligent use of information as a basis for rational change. This means two things: "good" data must be available, and the system must be organized and function in such a way that these data are utilized. (p. 10)

Evaluation of the literature points to several models that appear to have widespread acceptance. Six of these models will be discussed. They may be found in Figure 2 as described in Jenkins (1976). For each model, Jenkins summarizes main features, identifies strengths, weaknesses and assumptions, offers an example of application and suggests directions for small scale evaluation activities in which teachers might become involved.

1) Tyler's "objectives" model of evaluation is widely known and involves evaluating the efficacy of a curriculum in terms of the extent to which students achieve stated aims.

2) The Self-Study evaluation model is a useful part of formative, in-house evaluation of a curriculum

Figure 2: Stake's Chart of Prototypes of Curriculum Evaluation

Prototype	Tyler's Evaluation Model	Institutional Self-study	Stake's Countenance Model
Key Emphasis	Instructional objectives	Staff self-study	Description and judgement data
Purpose	To measure student progress towards objectives	To review content and procedures of instruction	To report the ways different people see the curriculum
Key Activities	Specify objectives; measure student competence	Discuss program; make professional judgements	Discover what audience wants to know about; observe; gather opinions
Key Viewpoint Used to Delimit Study	Curriculum supervisor; teacher	Classroom teacher; administrator	Audience of final report
Outside Experts Needed	Objectives specifiers; measurements specialists	None, but possible outside authentication or technical help	Journalists; social psychologists
Expected Teaching Staff Involvement	Conceptualize objectives; give tests	Committee discussions	Keep logs; give opinions
Risks	Oversimplify school aims; ignore processes	Exhaust staff; ignore values of outsiders	Stir up value conflicts; ignore causes
Pay-Off	Ascertain student progress	Increase staff leadership responsibility	Broad picture of curriculum conflicting hopes

Figure 2: Stake's Chart of Prototypes of Curriculum Evaluation (continued)

Prototype	Stufflebeam's CIPP Model	Taba's Social Studies Evaluation Model	Scriven's Goal-Free Evaluation
Key Emphasis	Decision-making	Cause and effect relationship	Evaluator's goal-free check-list
Purpose	To facilitate rational and continuing decision-making	To seek simple but enduring explanation of what works	To assess effects of program
Key Activities	Identify upcoming alternatives; study implications, set up quality control	Exercise experimental control and systematic variation	Ignore proponent claims; follow checklist
Key Viewpoint Used to Delimit Study	Administrator: director	Theorist: researcher	Evaluator
Outside Experts Needed	Operations analysts	Research designer; statistical analysts.	Jurist; curriculum analyst
Expected Teaching Staff Involvement	Anticipate decisions, contingencies	Tolerate experimental constraints	Make the program accessible
Risks	Overvalue efficiency; undervalue student aims	Artificality ignore personal values	Overvalue documents and record keeping
Pay-Off	Curriculum sensitive to feedback	Get rules for developing new programs	Data on effect with little cooption

innovation, but is somewhat vulnerable in that self description has low credibility. Another example of the staff self-study model would be the situation in which an outside evaluator offers technical assistance in the process of internal deliberation.

3) Stake's Countenance model extends the basic concern in the Tylerian model with congruence between intended and observed outcomes to include a more extensive descriptive data matrix as well as a matrix of judgement data. Sources of information are classified as prior conditions encounters and negotiations, and intended and unintended student learning and outcomes on others. Questions arise about logical contingency among intentions; empirical contingency among observations; and congruence at each level of intentions and observations.

4) In Stufflebeam's model, C.I.P.P. stands for the first letters of Content, Input, Process and Product. As the central emphasis is decision-making, this is the only model designated in the prototype chart as embodying the key viewpoint of the administrator or project director. This risk with this view of evaluation as a bureaucratic activity is that efficiency might be overvalued.

Context evaluation serves planning decisions to determine objectives; unlike the Tyler prototype's emphasis on stated goals, however, context evaluation questions the value of any stated goal and looks for unmet needs. Input evaluation serves structuring decisions to determine procedural designs. Process evaluation serves implementation, monitoring potential sources of failure and building up an interpretative description. Product evaluation serves recycling decisions based on the extent of achievement of project objectives.

5) Taba's Social Studies evaluation model basically follows the conventional ideas of educational research involving pre-tests and post-tests and experimental and control groups. Shortcomings of this approach to curriculum evaluation are in preventing the groups from meeting and discussion.

6) Scrivens Goal-Free model is that an evaluator needs to study a program's effects, intended and unintended, unhampered by contact with the statements of intent produced by program builders. The goal free evaluator does not adjudicate in advance the information or data that the evaluator will deem relevant. It is noted, however, that the goal-free approach is unlikely to meet accountability requirements since sponsors normally

wish to know whether a program achieves its stated goals.

These are six evaluation models in which curriculum evaluation may be viewed. It is through the results of curriculum evaluation that the need for change will be illustrated.

A review of the literature on the process of change within an organization refers mainly to its application of the process. These models can be applied to the process of change in education, since the education system is an organization. Depending on the organization that is seeking change, the models used for change and the roles of the change agents will vary. Adoptive models are those that are concerned with producing a specific change such as the linkage model (Havelock, 1968). Adaptive models are oriented toward producing a general state conducive to change. An example of this type of model is Intervention Theory Model (I.T.M.) (Argyris, 1970).

Sashkin (1974) describes the differences between the adoptive and adaptive models in the following statement:

> "The differences between them boil down to these: Is the aim to get the client to change in certain specified ways, to adopt certain new practices, to use certain new

> technological devices. If so, an adoptive model is appropriate. Is the aim to help the client become more adaptable, more open to change, and able to change in needed ways (whatever the specifics as defined by the client might be)? To accomplish this aim the client uses internal and external resources for change, rather than relying on outside help. An adaptive model is appropriate." (p. 209)

A description of these models as illustrated by Sashkin (1974) may be found in Figure 3.

Three adoptive models will be discussed first. These three approaches center on the diffusion and adoption of technological and social changes. All are oriented toward researchers developing knowledge which could be beneficial once put into practice. The aim of these models is to convince potential users such as educational organizations to put into practice some new device, mechanism, process or procedure that has been developed through research.

Research Development and Diffusion: (R.D.D.) The first and oldest model is technologically oriented and concerned primarily, though not exclusively, with how to get individuals groups and organizations to adopt and

Figure 3: Comparison of Six Models in Terms of the Roles of the Change Agent

ADOPTIVE CHANGE MODELS	ROLES		
	Consultant	Trainer	Researcher
RDD	Primary emphasis: the major function of the change agent is facilitating adoption of some specific innovation.	Not included: however, some training may take place in the sense that the client may be taught how to obtain similar knowledge in the future.	Research may be accomplished but this is rare and is not a part of the change process or necessary to it.
SID	Primary emphasis: the major function of the change agent is facilitating adoption of some specific innovation or practice	Not included: however, certain members of the client system may be made more aware of their roles as resources for new knowledge and other members may learn to seek them out and use them more effectively.	Research is not a primary focus and not part of the change process, although research done on this model has been used to "refine" it.
Linkage	Primary emphasis: the major function of the knowledge linker - the change agent - is effective diffusion of specific innovation (technical or social) by creating linkages between the knowledge source and the user; such linkages may be made permanent through roles carried out by an individual linker or by a linking group or as institutionalized procedures.	Training may occur in that the client learns more effective methods for getting information from external resources; in addition, the client may learn better internal data-retrieval procedures.	Research is not a focus, although considerable research has been done on the model and on the diffusion and utilization process; however, the model itself does not contribute to such research as a part of its normal operation.

Figure 3: Comparison of Six Models in Terms of the Roles of the Change Agent (continued)

ADAPTIVE CHANGE MODELS	ROLES Consultant	Trainer	Researcher
ITM	Consultation on process only, not on content problems: however, the interventionist does introduce the client to new methods of data-gathering, analysis, decision-making.	Primary emphasis on training the client in new skills and methods (process oriented).	Emphasized to the extent of training the client in research skills needed for generation of valid information prior to and during the change process: research for development of new behavioral science knowledge is emphasized conceptually, but does not seem an integral part of the model.
PC	Consultation on process primarily, but also on content: for example, the derivation-utilization conference introduces the client to new content knowledge resources.	Major emphasis on training the client in skills and methods for creating adaptive changes.	Emphasized mostly in evaluation of effects of specific changes and client training in certain research skills needed for data collection and diagnosis; the importance of the generation of new behavioral science knowledge is noted, but it is not an operational part of the model.
AR	Consultation on process is emphasized, but content consultation also occurs.	Major emphasis on training for development of internal resources for change.	Major emphasis on research as the basis for action, an important area of client training, and the source of new knowledge about change which can be used by behavioral science practitioners and theorists.

uuse such innovations as Learning Styles and Mastery Learning or more specificaliy computers and software in the classroom. Effective use of R.D.D. depends on marketing methods which serve to make the client aware of the beneficial use of new developments.

Social Interaction and Diffusion: (S.I.D.) This model is concerned with behavior change to a greater degree than R.D.D. is. It does, however, retain emphasis on adoption of technological innovations, such as acceptance of new attendance record forms by teachers. The primary orientation, is similar to R.D.D.; to persuade people to adopt and use an innovation. The S.I.D. model is based on the premise which is supported by a large body of evidence that certain "opinion leaders" set trends and others follow. The followers adopt innovations after contact with these "opinion leaders" who have already used these innovations and recommend that others do as well. The use of Benjamin Bloom's Taxonomy and Madeline Hunter's theories of Effective Education are examples of how "opinion leaders" play an important role in educational change, using the S.I.D. model. Problems may arise with the use of this model when some leaders are unaware of their role in implementing change and others who may not want to be identified.

Linkage: This model focuses more on the process of

adoption. Linkage, developed by Havelock (1968), basically is concerned with the roles of the disperser who links the research source with the user of innovation. The Linkage model considers significant the educator learning how to obtain and use the information externally and internally. In the case of the Roman Catholic School Board for St. John's, this is evident in that they are planning to use the Effective School System model for this board. They are following the formal plan used by the province of Saskatchewan. The board has brought in several specialists to assist in the implementation of this plan. Problems with the model seem to be that lack of emphasis on adaptivity (Sashkin, 1974).

The three adaptive models which are oriented toward development of adaptive capacity in a educational system. The adaptive capacity is the ability to be aware of needs for change and to plan, implement and evaluate action changes. These models all stress educator participation in specific change efforts. The educator learns to use the change model by applying it to specific real problems with the help of an external change agent. All three models are based to a certain degree on an approach developed by Lewin (1947) called action-research (Sashkin, 1974).

Intervention Theory Model: (I.T.M.) This model is described by Argyris (1970). It differs from the other two adaptive models in two ways as described by Sashkin (1974):

> First, this model is oriented exclusively toward changes in internal processes. The interventionist is relatively unconcerned with technological or structural change. He does not help the client go outside the system for change resources, with the possible exception of calling in another change agent who possesses certain specialized skills.
>
> Second, there is less emphasis on generation of research knowledge relevant to the change process. Although there is considerable emphasis on collecting and analyzing data within the client system and on monitoring effects of actions, the aim is to provide the client with skills for accomplishing activities which create effective, adaptive internal changes. In practice there is no aim to generate experimental knowledge on the process of change or to build better behavorial science theories about the change process. This fits with the first emphasis on the internal

processes of the client system. (p. 210)

Planned Change: (P.C.) This model developed by Lippitt, Watson and Westley (1958) differs from I.T.M. in two ways: First change resources outside the system as well as within, receive attention. The model is not solely oriented towards process change, although this type of change does receive most of the focus.

Second, more specific attention goes to evaluation action changes. The P.C. model concentrates more than the I.I.M. model on measuring effects to support effective change and further planning. However, as in the case of the I.I.M. model, generation of behavioral science knowledge on change process is not emphasized in practice (Sashkin, 1974).

Action-Research (A.R.) The A-R model combines the attributes of the I.T.M. model and P.C. model as well as creating specific changes which develop client resources for self-change and future adaptability. These changes include client training in research methods needed for data collection, problem understanding, and evaluation of change attempts. The results are increased behavioral science knowledge about change. To accomplish this the change agent fulfills three roles, those of consultant, trainer and researcher.

In concluding the description of the comparison of six change models in terms of the roles of the change

agent in Figure 3 by Sashkin (1974), it is important to note that the difference between adoptive and adaptive change models in general is more significant than the differences among the three models of each type. the three adoptive models are useful in certain circumstances. However, effective change is based primarily on the three adaptive models (Sashkin, 1974).

From this broad view of change it is necessary to focus more on the application of the fundamentals of educational change. This is an onerous task because research states that it is difficult to find a single model that can best be used to change curriculum. Rather it points out that any one of several models should be viewed when looking at the process of curriculum change. This creates a problem in that there are several processes for educational change in curriculum and it would be beyond the scope of this paper to analyze a large number of these. It is for this reason that there was a need to find a model that could encompass the causes and processes of educational change.

The model selected is described in Figure 4 by Fullan (1982). The chart is divided into four groups that affect the implementation of change. These groups are in turn divided into sub-groups.

Figure 4: Factors Affecting Implementation

A. Characteristics of the Change

1. Need and relevance of the change

2. Clarity

3. Complexity

4. Quality and practicality of program (materials, etc.)

B. Characteristics at the School District Level

5. The history of innovative attempts

6. The adoption process

7. Central administrative support and involvement

8. Staff development (in-service) and participation

9. Time-line and information system (evaluation)

10. Board and community characteristics

C. Characteristics at the School Level

11. The principal

12. Teacher-teacher relations

13. Teacher characteristics and orientations

D. Characteristics External to the Local System

14. Role of government

15. External assistance

In group A, Fullan looks at four aspects of the characteristics of change. The first step is the area of need and relevance of the change. In this paper there was a documentation of need for change in the physics curriculum as stated in chapter two. It has been discovered that implementation is more effective when specific needs are identified (Fullan, 1982).

Step two looks at clarity and how it is a problem in the change process. Even when there is agreement that some kind of change is needed as is the case in this paper when teachers want to improve some area of the physics curriculum, it may not be clear exactly what the adopted change should be. The change may not be sufficiently well developed to be implementable. It has been found that the majority of teachers were unable to identify the essential features of the innovation they were using (Fullan, 1982). Hopefully, this will not be the case with the physics curriculum discussed earlier. Fullan (1982) states: "... lack of clarity - diffuse goals and unspecified means of implementation - represents a major problem in the implementation stage; teachers and others find that the change is simply not very clear as to what it means in practice" (p. 57).

In step three, complexity refers to the difficulty

and extent of change required of the individuals responsible for implementation. The actual amount depends on the starting point for any given individuals or group. The main idea, however, is that any change can be examined in regard to the difficulty, skill required and extent of alterations and beliefs, teaching strategies and use of materials. The problem of starting the process for change in the physics curriculum was not overly complex. In areas where complexity creates problems for implementation, it may result in greater change because more is attempted. Berman and McLaughlin (1977) found that: "...ambitious projects were less successful in absolute terms of the percent of project goals achieved, but they typically stimulated more teacher change than projects attempting less" (p. 88). This implies changes that more complex changes are more thorough as a result of the extra effort which the project required or inspired. To reflect this it is often stated: "Little ventured, nothing gained".

Step 4 quality and practicality of program is directly related to learning materials, technologies or other products Fullan (1982) states:

> The history of product quality and its relationship to the other three variables

> (need, clarity, complexity) is very revealing. To say that the importance of the quality of materials is self-evident is to underestimate how adoption decisions are made. Inadequate quality and even the simple unavailability of materials can be the result when adoption decisions are made on the grounds of political necessity or perceived need without time for development. (p. 59)

This causes reflection to the profile of the physics curriculum that needed to be changed earlier in this paper. The program that is hopefully being replaced is one that was introduced in 1976. It was brought in on an interim basis until something better was discovered. Originally, the program was funded financially but after time the funding for laboratory equipment and summer institutes for teacher training disappeared. It took twelve years for the evaluation of curriculum change to take place. To summarize these four steps Fullan (1982) states:

> ... the lack of demonstrable need for change, the lack of a clear practical picture of the discrepancy between current practice and what is proposed, insufficient attention to the complexity of change in terms of extent and difficulty, and lack of adequately developed

> and good quality materials constitute one major set of barriers to implementation. While these can and should be assessed objectively, it is important to recognize that they must be understood in relationship to individual implementors - that is in relationship to what they perceive as needs, as the extent of change, as difficulty and as good quality/practicality. (p. 62)

In group B, Characteristics at the school district level (see Figure 4), Fullan identifies six factors affecting change. These factors and those in group C and group D focus on the social conditions of change (see Figure 4). These social issues play an important role in educational change.

Step five, the history of innovative attempts, looks at teachers and the number of negative experiences they may have had with previous attempts at educational change in their district. This would cause teachers to be skeptical and indifferent toward the next change they may be presented with despite its advantage. An important factor here is support for change that is to be implemented. This support should be present in all forms including financial and administrative. Without

continued support the process of change is doomed. Fullan (1982) does, however, express a positive view of change, despite the negative experiences that may occur along the way and it is: "... nothing is more gratifying psychologically than attempting a change that works and benefits our students" (p. 64). It is the hope and desire for this type of success that inspired the effort for physics curriculum change discussed in this paper.

Step 6 deals with the adoption process. This entails selecting a well thought out plan to implement the process. It is necessary to have the goals and objectives set out before the various stages of the implementation take place. It is also important to involve a representative person, or group of persons as they are affected in the process. This would give input that will prevent pitfalls in latter stages of the process. It may also be necessary to ensure certain stages are in place before the project continues.

Step 7 points to district administrative support. This can be viewed both positively and negatively. From the positive point of view, if you have an administrator (superintendent or other central office personnel), who is conscientiously looking at change and promoting it,

then this support filters down through the ranks. For example, if you have a proposed change taking place in a school district and the superintendent and support staff are out visiting the schools and encouraging the process as it takes place in the different schools then the people who are directly involved react positively to the change. Conversely, lack of administrative support may negatively effect change particularly if it comes solely as a directive from the superintendent's desk. Support from central office is necessary for change to take place. For new initiatives to be successful the endorsement and encouragement of the superintendent visiting all schools must be perceived by the teachers, who will be responsible for implementing many of these changes. Otherwise, teachers may be reluctant to participate in these changes.

Step 8 considers staff development and participation, whether it be voluntary or compulsory. It is important that teachers receive concrete training with ongoing continuous assistance and support and regular meetings with peers and other individuals, during implementation. Teacher participation in decisions concerning implementation is necessary for program acceptance. It is through this teacher participation at the "grass roots" of the change process

that programs can be implemented to meet the needs of this particular situation. A model for change may be chosen, for example, the effective school model in Saskatchewan may work there, but, when applied to Newfoundland, this model will need to be adapted to the people and the environment. Teachers participating in this process are the ones that will make it fit this new environment. Evidence to support this may be found in Berman and McLaughlin (1978) that states:

> Teacher participation in decisions concerning project operations and modifications was strongly correlated with effective implementation and continuation. The reasons for this powerful effect were easy to uncover. Teachers, who are the closest to the problems and progress of project activities are in the best position to suggest remedies for perceived deficiencies. Moreover, where project activities and objectives reflected significant teacher input, the staff were more likely to invest the considerable energy needed to make the project work. (p. 29)

Step 9 pertains to time line and information systems (evaluation). The time line as discussed earlier in the change of physics curriculum was

important because pilot programs can only take place at the commencement of the school year. In this example, one can see that time is an important factor. You need to have your teacher training and professional development in place before the school year begins. Student texts and laboratory materials should have all arrived before the school year commences. It is difficult for a teacher involved in a pilot project when things like student texts do not arrive until the school year is half over or some other equally unfortunate event occurs. As more problems arise, teachers may become disillusioned with the change, and wary of future involvement in other changes. It is necessary that a time line for the process of change be set. It should be flexible but not to the extent that its open endedness leads to ambiguity about what is expected. It should also state clearly what constitutes progress. Time lines are important in the evaluation of incoming information. Studies have to be evaluated and prepared to determine if a pilot program has been a success. The change, to be implemented throughout the school board, can be prepared at the beginning of the year. In regard to evaluation of information, Fullan (1982) states: "... it can be noted that an emphasis on collecting and using diagnostic information about student learning and other implementation problems has

been found to be strongly related to school improvement" (p. 70).

Step 10 looks at the role of the board and community characteristics. Community support of a school will have an effect on introduction of various changes within the school. These effects may be positive or negative. From a negative point, one can look at the Scopes trial, where a community banded together to prevent the instruction of evolution in the Science class. A positive effect has been the development of Health and Family Living courses, that educate students about controversial topics like A.I.D.S., a task that many parents prefer for the school to do.

The next area of discussion, group C, School level factors, involve the influence of the school on the implementation of educational change. These give a view of the school environment with respect to change.

In step 11 the role of the principal is listed. The principal's role is very important in a school because he is the educational leader. His active and guiding influence, if positive, will enhance and support any educational effort the staff may entertain.

However, it has been the practice of some principals to be an administrator solely and not become involved in curriculum change, or other educational changes.

Step 12 involves teacher-teacher relationships. Fullan (1982) describes the role of teacher - teacher relationships in the following statement:

> The theory of change which is evolving clearly points to the importance of peer relationships in the school. Change involves resocialization. Interaction is the primary basis for social learning. New meanings, new behavior, new skills depend significantly on whether teachers are working as isolated individuals or exchanging ideas, support and positive feelings about their work. (pp. 71-72)

Some of the difficulties with changing the physics curriculum discussed in this paper can be understood in reference to Fullan's statement. There is usually only one physics teacher in each high school in Newfoundland. This sets up the scenario where physics teachers are working as isolated individuals. They usually meet only once every year for two days. It is during this period that ideas are exchanged. Therefore, it is difficult to receive positive feelings of support from people who

only meet so infrequently under these circumstances.

Step 13 Teacher characteristics and orientations, deal with academic qualifications and experience. It is also related to the environment the teacher is working in. If the environment is positive and necessary materials are available, then the teachers are able to successfully carry out their duties. In this case a qualified teacher with experience, can make a positive contribution to the changes that will improve a school's educational success.

Following is an accurate description by Little (1981) based on her study of work practices in six urban schools, that summarizes the effect of school level factors on change.

> Teachers engage in frequent, continuous and increasingly concrete and precise talk about teaching practice (as distinct from teacher characteristics and failings, the social lives of teachers, the foibles and failures of students and their families and the unfortunate demands of society on the school). By such talk teachers build up a shared language adequate to the complexity of teaching, capable of distinguishing one practice and its virtue from another ...
>
> Teachers and administrators frequently observe each other teaching, and provide each other with useful (if frightening) evaluations of their teaching. Only such observation and feedback can provide shared referents for the shared language of teaching and both demand and provide the precision and concreteness which makes the talk about teaching useful.

> Teachers and administrators plan, design, research, evaluate and prepare teaching materials together. The most prescient observations remain academic ("just theory") without the machinery to act on them. By joint work on materials, teachers and administrators share the considerable burden of development required by long term improvement, confirm their emerging understanding of their approach and make rising standards for their work attainable by them and their students.
>
> Teachers and administrators teach each other the practice of teaching. (pp. 12-13)

This leads to group D, characteristics external to the local system. Here we are looking at provincial or state departments of education. Other agencies may also be involved such as research and development agencies from the private and public sectors. The public sector is discussed in point 14, Government agencies. The system of educational control in Newfoundland is described in Appendix E. The problems exist between both systems, (educational organization and government), through inability to communicate except through a large bureaucracy. There appears to be a lack of a clear, efficient means of communication. In looking at the physics curriculum in this paper, it is easy to see that this is a valid statement, since the process took four years before a change started to take place. Dealing with the bureaucracy was frustrating and discouraging. At times it appears that no progress was

taking place. However,one keeps striving for change because the problem does not go away until the change is implemented. Government agencies are important in supplying the funding that is used to support programs in education. The funding covers building materials, supplies, teachers, administrators, etc., that go into making an educational organization.

Step 15, external assistance, is the final step. This assistance can come from non-biased organizations that do standardized testing of students to determine the level of their skills at different age levels. The results of these tests can tell us about weaknesses in the curriculum. These tests help us to identify the need for change as was the case in chapter one of this paper. As a result, these external organizations have a role to play in educational change. External assistance may also come from research and development organizations. They may provide assistance through the development of new programs, methods of teaching and also by acting as consultants to the process of change.

In conclusion, this chapter gives a broader perspective to educational change, than was necessary based on the scope of physics curriculum change that has

occurred to date. The need for and the history of educational change was presented. The identification of the need for evaluation of education to identify needs for educational change is discovered through evaluation. This led to an appraisal of six models of evaluation from the literature. These six models analyzed the different approaches that may be used in curriculum evaluation. This led to a more global view of change in organizations rather than the myopic perspective we obtained from looking at the processes of change in science (Physics) curriculum. At this point, a comparison of six change models were discussed and divided into two categories: 1)Adoptive, and 2)Adaptive. Each category contained three models that could be used for change in organizations, such as education. The final task was the selection of a model specific to educational organizations that could satisfy the needs for change. This model was discussed and evaluated where possible, to curriculum change as applied to science (Physics) curriculum change discussed in this paper.

5: Curriculum Change in Physics

The final chapter of this paper will summarize the process of curriculum change as it applied to the science (Physics) curriculum, being used in the Newfoundland education system. It will also contain some viewpoints from the literature that may have not been illustrated previously. One point that has not been expressed is that if educational change is to take place then it is important to train teachers to be more innovative and more accepting of innovation. Raymond Lallez in his O.E.C.D. report (1974) states:

> For training colleges wishing to provide a new style of training designed to introduce a large number of important innovations into teaching practice and the educational system and, more important, infuse everyone with what we have called the spirit of innovation, the first major hurdle is obviously the education their students have already had. They have of course been through primary and secondary levels, and until these have been recast by generations of teachers still to be trained, a real "deconditioning" process is necessary. (p. 425)

Therefore, in order for educational change to take place in a highly changing technological society, it is going

to be necessary to educate teachers to be receptive of change. This does not mean they jump on the band wagon of every new educational change, but evaluate and analyze the change and if beneficial to the education organization, then adopt and work towards its implementation..

To illustrate the process of change, the example of the science (Physics) curriculum in Newfoundland will be used. A statement of the need for change in Physics curriculum was made in Chapter One of this paper. The importance of this statement and the documentation of this need in Chapter Two were illustrated by Fullan's (1982) model, (Figure 4).

In Chapter 2 the documentation of the need for Physics curriculum change was supported by four Appendices. Appendix A was a report that analyzed teacher and student questionnaires and the information reflects a need for Physics curriculum change. In Appendix B, teachers were given a new forum in which to evaluate the need for a change in curriculum by means of a teleconference and another teacher questionnaire. As can be seen from the Newfoundland Teachers Association Science Councils Physics Representative's letter in Appendix C to the Director of Curriculum and Instruction

of the Department of Education, 88% of the Physics teachers returning questionnaires had made this choice: "The Department of Education should set up a Physics Curriculum Committee to re-examine the whole course and evaluate alternate text materials for possible piloting and future adoption". Appendix D communicates the feelings of the Department of Education and its acknowledgement of the need for "Physics renovation".

At this stage, it is necessary to refer to several of the steps in Fullan's (1982) Model for change Figure 4, as discussed in Chapter four. These are connected; the first is the time-line and the second is the role of government. It has been demonstrated in this example of the Physics curriculum that communication between teachers and the powers (government) that control change need to be greatly improved. It will have taken four years for this change to reach a pilot stage that should last two years. This demonstrates the perseverance and endurance of those teachers pursuing change. However, it is discouraging to teachers seeking change when the time-line for the process of change is this slow in progress. Teachers with ten and more years experience who have been frustrated with the change process in the past may shudder in memories of grief when the words change or

innovation are mentioned. In response to this it is necessary for departments of education, whether provincial or state, to obtain an improved pulse of the educational organization. In looking at the rate of technological change and society, it will be beneficial for governments that represent these societies to expedite this process in order to sustain themselves.

In Chapter Three the model for science curriculum change in Newfoundland (Figure 1) was discussed. In Appendix E of this paper there is a summary of how the educational system in Newfoundland works. This was necessary in order to understand the process of the model in the Newfoundland environment.

Chapter Four demonstrated how the example of curriculum change in this paper relates not only to the broader view of organizational behavior, but specifically to the educational change process.

Before closing it is necessary to look briefly at the future of educational change. Drucker (1974) states:

> Unless the long range is built into, and based on, short range plans and decisions, the most elaborate long-range plan will be an exercise

> in futility, and conversely, unless the short range plans, that is, the decisions on the here and now, are integrated into one unified plan of action, they will be expedient, guesses and misdirection. (p. 122)

This gives direction for administrators in the educational organization and points out the importance of planning. Cunningham (1982) states:

> Educational administrators must be able to anticipate the future; that is, be able to visualize how choices made today will influence tomorrows educational practice. This requires that administrators be prepared to look beyond the traditional firing line to the future alternatives that will be available to their educational systems. (p. 245)

It will be important to the educational organization that leaders of vision will be in control. It is from this visionary leadership that teachers are directed and inspired.

Teachers have an interest and a desire for educational change. If effective educational change is a process of personal learning and socialization, improvement will come to the extent that individual teachers can be helped. Particularly, to the extent

that they can be brought in contact with each other and with external resources in a focused way, find their way around to a given change. This is not to say that all teachers are interested in change, but those that are not will have to adapt to changes as they are put into place. This will be happening at an ever increasing pace as society and technology advances.

It is necessary to point out that school improvement is related not just to what teachers do and think. Equally important is what those around them at the school, district, province, state and federal levels do. Change is often thought only in terms of the teacher. If change is going to take place than every sector is going to have to face up to its responsibilities in the process. In this network the most powerful source to the teacher will be the school principal. Therefore, it will be imperative that this person be knowledgeable and supportive.

In closing, it is important that the process of change be recognized as being complex, difficult and requiring commitment. Nevertheless, change is a process that is necessary in an evolving technological society. Fullan (1982) states:

We may not be able to introduce needed

educational changes at will, nor be successful with all those which are introduced, and we have no reason to be more optimistic about change in education than in other societal institutions. But we can no longer hide behind the excuse that worthwhile change in practice through deliberate means is impossible. (p. 297)

APPENDIX A

N.T.A. Science Council

Physics Branch

A Report on the High School Physics Program

Prepared by : Physics Committee

Cecil Lake (Chairman)

Robert Kelsey

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INTRODUCTION

The Science Council is a body of the Newfoundland Teachers Association (N.T.A.) which is responsible for promoting the advancement of science teachers in this particular field. This is done through a science newsletter and an annual general meeting in which many professionals from, in and outside, the N.T.A. present new, innovative or revised methods of science instruction in a particular field.

The many branches of the Science Council are composed of teachers who are willing to commit themselves to carrying out the duties of that branch. The physics branch, at the last Annual General Meeting, was instructed by its members to evaluate the present physics program in Newfoundland and Labrador. To meet this requirement, a committee composed of Robert Kelsey, St. John's and Cecil Lake, Corner Brook carried out an evaluation based on the opinions of high school physics teachers, students who have completed the high school program and are attending post-secondary institutes and physics instructors in such post secondary institutes as Memorial University, Sir Wilfred Grenfell College and the Marine Institute in Newfoundland. The information was primarily attained through questionnaires and interviews. The statistics presented in this paper reflect the views of Physics teachers across the province.

INFORMATION FROM HIGH SCHOOL Physics TEACHERS

A questionnaire was forwarded to all areas of Newfoundland and Labrador to attain a good representation of teacher viewpoints in small to very large schools. The following is a summary of the teacher responses to this questionnaire.

(1) The average number of years teaching the Physics : A Human Endeavour -- 6.04 years.
(2) The percentage who would like to see the present program replaced was 65%. Seventeen percent were satisfied with the program while the remainder were undecided.
(3) 54% were dissatisfied with the material content while 33% found it satisfactory.
(4) 53% would like to have a new book to cover both Physics 2204 and Physics 3204.
(5) 60% would like a Physics book with a lab manual included within the text.

In addition to percentage responses, teachers were asked to comment on the following:

Topics that should be dropped

The most frequent response was the historical development section followed by the section involving

Simple Machines.

Topics that should be revised

The responses varied extensively with no one topic being prominent.

Topics to be added

Again replies were varied but three areas were common to many teachers. These were: 1) The modern applications of Physics principles, 2) Angular momentum and 3) Nuclear Physics.

TEACHER EXPERIENCE

When the present Physics program was introduced in Newfoundland and Labrador, it was supplemented by a Physics Institute at Memorial University. The inservice program gave teachers who attended a philosophy of instruction, reasons for changing to a new program and teaching techniques for the new program. From our questionnaire, Physics teachers had an average of six years of experience with Physics: A Human Endeavour. The range was from two years to the inception of the program. Several had attended the Physics Institute but most had not. Those who did not attend had to depend on the course description to understand the thesis of the program.

COURSE REPLACEMENT

The percentage assigned to the number of teachers who wanted the course replaced can be misleading when the variation in teaching experience is further refined into two experience groups two to five years and six years to program inception or greater. It was found that the more experienced Physics teachers were 77% in favour of replacing the course while only 15% were against such a move. 8% were undecided.

MATERIAL CONTENT

When teachers responded negatively to the question concerning the material content, their responses implied that certain topics should be dropped, revised or added. Under the section that asked teachers to list topics that should be dropped from the course, 20% indicated the historical development section. Most teachers did not respond to this question which may indicate that most teachers are content with the topics that are covered.

This idea may be further reinforced by the number of teachers who would like to see some topics revised rather than dropped. Topics that should be revised were:

Circuits

Light

Graphical Analysis of Motion

Sound

Field Concepts

Vectors

Waves

From those topics listed, it can be seen that most are from Physics 3204.

In response to the question of what topics should be added to the course. There was a tie between angular momentum and the modern application of physics principles. At present, adding topics to a program would have to be done by the teacher of the course which presents a time problem.

LIMITATIONS

The third level physics course has to be completed on time which presents problems for a teacher who would like to supplement the course material. The reason for the time restriction is because all students in Newfoundland write government examinations at the end of the school year. An alternative would be to revise the present program by reconstructing the topics to be covered. For example, the topic of waves is covered in the last chapter of Physics 2204 and taken up again in the first chapter of Physics 3204. It would be more

logical if these two chapters were combined to give a more unified approach to the topic.

BOOK REQUIREMENTS

Since the majority of teachers would like to see the program replaced. A further question was put to each respondent concerning the use of a single book rather than two separate books if the present Physics program were replaced. Most teachers would like to see a single book to cover both levels of Physics. This would make for better organization both for the student and for the teacher.

Teachers were also asked about the use of a laboratory manual separate from the text or included within the text. Sixty percent were in favour of a laboratory manual within the text.

STUDENT RESPONSES TO QUESTIONNAIRE

To select a broad spectrum of students who had taken high school Physics, questionnaires were forwarded to Memorial University, Sir Wilfred Grenfell College and the Marine Institute. Questionnaires were distributed, primarily, to students who had completed at least one post-secondary Physics course. The intent behind choosing this group was to ascertain a more accurate

comparison, by the student, between the high school Physics program and those Physics programs at the post secondary level.

When all questionnaires were analyzed. It was evident that students at Memorial University and Sir Wilfred Grenfell College attained a higher average mark in high school Physics (Physics 2204 - 83%, Physics 3204 - 82%) than the Marine Institute students who were much lower at 69% and 66% respectively. The latter group, having a lower percentage, may reflect some of the weaker students in our high school program.

The students at Memorial University and Sir Wilfred Grenfell College were surveyed for their opinions on the high school Physics courses in the following areas :

(1) Laboratory experiments

(2) Problem solving

(3) Text material

The tables below are percentage responses to these specific areas.

Laboratory Experiments

	Marginal	Satisfactory	Unsatisfactory	Does Not Apply
Physics 2204	27	33	27	13
Physics 3204	29	38	22	11

Problem Solving

	Marginal	Satisfactory	Unsatisfactory	Does Not Apply
Physics 2204	26	51	20	3
Physics 3204	21	61	13	5

Text Material

	Marginal	Satisfactory	Unsatisfactory	Does Not Apply
Physics 2204	26	64	8	2
Physics 3204	23	65	6	0

It is evident from these results that students are generally satisfied with the laboratory experiments, problem solving and text material. To further support these opinions, students from Memorial University responded 68% positively to the question about the ability of high school Physics to prepare them for university level Physics. When the same question was presented to students at the Marine Institute, they responded affirmatively by 72%.

Students may feel they have been adequately prepared but when they were asked if they had difficulty with post secondary Physics material, students at M.U.N. replied 53% positively to this question while the Marine Institute students expressed a 47% affirmative response.

What these statistics may suggest, as reiterated by many of the students' comments, is that the depth of treatment of certain topics is not adequate to prepare them for the university or technical school level Physics courses. This may explain the percentages assigned to the last question. This would imply that fewer topics should be covered, but these topics should be studied in depth.

Students at both M.U.N. and the Marine Institute were concerned about the laboratory situation. Some of these students came from smaller schools which do not have well equipped laboratories. They felt that more laboratory experiments would have helped them grasp the topics more readily and prepare them for Physics laboratories at M.U.N. and the Marine Institute.

POST-SECONDARY PHYSICS TEACHERS

Teachers in the post-secondary sector are a valuable resource to high school teachers. They can inform of new developments in the field of Physics as well as provide feedback in the areas concerning curriculum. Topics covered in the first year Physics courses at the post-secondary level could be introduced in high school so as to prepare the student for a more indepth treatment.

In discussion with these professionals, they felt that the topics covered in high school do correspond to Physics courses at the university or technical school level. Their major concern, like that of the students, was with the depth of treatment of certain topics. In some cases, they felt the topics were only touched briefly; not giving the student sufficient information to fully comprehend the topic. Indepth treatment of all topics in high school Physics can have several drawbacks such as :

(1) Lack of time to complete each Physics course

(2) Teachers may not have enough experience in Physics to do an indepth treatment. After all, how many Physics teachers have a major in Physics?

(3) Indepth treatment would not give students that broad spectrum of Physics necessary for the various areas of study.

Another concern of post-secondary Physics teachers is the lack of formal laboratory experience especially those students coming from smaller schools where laboratory space and equipment are at a minimum. As a

teacher at the College of Trades and Technology: Physics section stated in a letter to this committee "... the comments received from our students support more laboratory work. We agree that the course should contain at least a two hour laboratory period."

All teachers are aware that laboratory space and equipment are expensive but to teach a course such as Physics: A Human Endeavour, laboratory equipment is essential. Also, teachers of these courses should have some experience in the operation of this equipment so as to maximize student learning.

DISCUSSION

There have been many concerns expressed by teachers, students, and other professionals about the high school Physics courses, though it is agreed that it does meet the basic needs of students. The concerns vary from the number of years the present course has been in Newfoundland and Labrador without a review, to the use of laboratories and depth of treatment of material.

When reading through the philosophy of instruction, a sentence sticks out which does not appear to be correct for the present day. It reads Department of

Education (1982) "... the teacher should be aware that it is not the purpose of high school Physics to train physicists or even specifically to train prospective university Physics students" (p. 1). The post-secondary professionals may take exception to this sentence since they depend on high school Physics teachers to prepare a student to handle university or technical school Physics. It is in the opinion of this committee that each stage of a student's learning is geared in preparation for the next level of learning. That is why science, like mathematics, is taught at each grade level. If that is not the case, then there should be two distinct Physics courses; one for students who are only graduating from high school and one for university or technical school bound students. Most students who do take Physics 3204 are usually taking it, mainly, to satisfy an entrance requirement for specific areas of post-secondary education. Therefore, if the majority of students taking third level Physics are serious, then the depth of treatment of certain topics should be reflected in the course.

To adapt to a changing society, education must keep pace or risk stagnation. Most high school courses have changed or new courses have been added to meet this challenge. Physics: A Human Endeavour had not changed

except for the introduction of an answer manual for Physics 2204 in 1984 and a Teacher's Guide in 1985. Physics 3204 has a Teacher's Guide but still does not have an answer manual.

It is known that introducing a new program is very expensive but it should also be considered that this Physics program has been in place generally longer than any other science course. It is not keeping pace with the modern advances in Physics.

Since this course has been patterned after a human endeavour approach which implies a greater student involvement, the necessity of laboratories and laboratory equipment is essential to complying with the philosophy of instruction. As outlined in the philosophy of instruction, Department of Education (1982), "It is worth stating that it is often through laboratory activity that abstract concepts are given the concrete base which is so necessary for comprehension by the student at this level of mental development" (p. 9). Further, under the objectives of Physics 2204, it states, Department of Education (1981), "It is perhaps self evident that the senior high school Physics laboratory must be extensively utilized if these objectives, in particular, and the aims of public

education, in general, are to be met" (p. 4). From these two statements, it is obvious that laboratory work is a necessity and meeting that goal may prove to be difficult because the numbers of schools offering Physics has grown extensively from 73 schools in 1981 to 131 schools in 1985. This indicates that Physics has spread to many smaller schools; some of which are ill-equipped to effectively teach such a course. To a certain extent, some teachers in these smaller schools may not have a good background in Physics. This does not imply that they cannot teach Physics but rather they may not be able to give the necessary treatment the philosophy of instruction dictates.

Since the introduction of zero based budgeting to many schools, it has become evident that school science budgets have decreased to a point where replacing or purchasing equipment is almost impossible. This puts a further strain on teachers who are trying to teach the course according to the guidelines under the philosophy of instruction.

A possible solution to the problem of laboratory space and equipment was suggested by Mr. Harvey Weir, M.U.N. Physics Department. Mr. Weir has been actively involved in preparing a first year video tape Physics

course for the university. Mr. Weir informed this committee that the video course could be adapted for use in high school Physics though money would have to be expended for Educational Television (E.T.V.) time, a technician and video tape material. Mr. Weir is prepared to volunteer his time to adapt the present video tapes to a high school application. These tapes would be a very valuable tool to the teacher who is limited in space, equipment and expertise. The question, how adequate are the audio visual materials used in Physics 2204 and Physics 3204, was asked. The table below shows the average percent response.

	Marginal	Satisfactory	Unsatisfactory	Does Not Apply
Physics 2204	24	12	24	40
Physics 3204	25	15	21	33

These statistics would seem to indicate a generally unsatisfactory level of audio-visual material. The 'Does Not Apply' category is the most outstanding statistic. On average, 40% of the students did not use A/V material in high school courses. This is due in part to the lack of good audio-visual material from the National Film Board or the Dept. of Education. When material is available from the Dept. of Education, it has to be delivered by mail to schools outside

St. John's which can account for delays and, in many cases, the unavailability of particular pieces of material. The development of a video cassette series could lessen both problems by showing students actual laboratory experiments and supplementing the text material. Because the tapes could be duplicated and a series could be available at each school, duplication would involve a minimal cost in comparison to allocating funds for the improvement of many laboratories.

RECOMMENDATIONS

1. The present Physics program be replaced with a new program which would meet the needs of all students.

2. If a new program is not introduced, the following should be considered:

   (a) The introduction of supplementary text material pertaining to modern applications of Physics principles or any other areas that need revision.

   (b) The upgrading of Physics laboratories and equipment.

   (c) A greater availability of audio-visual material for Physics 2204 and Physics 3204.

   (d) A greater need for problem solving laboratories supplemented with educational

computer software.

(e) Re-organize the present sequence of topics in Physics 2204 and 3204 so as to retain continuity.

3. A committee be formed to evaluate the present Physics program. The committee should consist of two post-secondary Physics teachers, a member from the N.T.A. Science Council - Physics branch, the Science Consultant for the Department of Education and one high school Physics teacher.

CONCLUSION

This committee has reviewed the present Physics program as instructed by the members of the N.T.A. Science Council. Its intention was to get the views and opinions of high school Physics teachers, post-secondary Physics professionals and students who have completed the high school Physics program. The results from this survey appear to indicate a need to review the present high school Physics program with the intention of improving the quality of high school Physics. It is hoped that a prudent course of action will be implemented based on the recommendation of this committee.

Physics 2204/3204 Teacher Questionnaire

Arising from the Science Council AGM in Gander, a resolution was passed requesting that a select committee be granted permission by the Department of Education to investigate the possibility of reorganizing or replacing Physics" A Human Endeavour. However, before any proposal can be made to the Department of Education, we would greatly appreciate your input from the following questionnaire.
(Remember -- SPEED = DISTANCE/TIME -- the faster we get a reply even from the greatest distance, the quicker we can get something done)

1. How many years have you taught Physics: A Human Endeavour?_____

2. Would you like to see a new Physics course introduced? Yes__ No__

3. Is the level of material satisfactory? Yes__ Too High__ Too Low__

4. Is the material covered SATISFACTORY_____ or UNSATISFACTORY_____

5. What topics would you like to have dropped?_____
_____
_____

6. What topics would you like to retain?_____
_____
_____

7. What topics would you like revised?_____
_____
_____

8. What topics would you like added?_____
_____
_____

9. If a new course is warranted would you like a hard cover book for both levels? YES___ NO___ With a lab manual included within the book? YES___ NO___

10. If a new course is not introduced, would you be willing to take an off-campus video tape credit course from Memorial University that will focus on aspects of Physics: A Human Endeavour? YES___ NO___

11. Would you be willing to contribute to the formation of a bank of questions from which Physics teachers could withdraw samples?
YES___ NO___

COMMENTS (Please use the back of the page)

Science Council Questionnaire

The Physics branch of the N.T.A. Science Council is conducting an evaluation of the present Physics program in the high schools of Newfoundland. As a part of this survey, the Science Council would like to get your opinions on the Physics courses you completed during high school.

THE FOLLOWING QUESTIONNARIE IS TO BE COMPLETED ONLY BY STUDENTS WHO HAVE COMPLETED BOTH PHYSICS 2204 AND 3204 IN NEWFOUNDLAND AND LABRADOR HIGH SCHOOLS SINCE THE INTRODUCTION OF THE REORGANIZED HIGH SCHOOL PROGRAM (GRADE XII).

1. What was your course mark in Physics 2204?_____ in Physics 3204?____

2. Which Math course (or courses) did you do in your final year in High School (and your mark)?_____

3. List any other Physics courses you have completed (with course marks):_____

4. What is your intended major in University?_____

5. When you began this post-secondary Physics course, did you have difficulty with the material (Yes or No)?_____
   If "YES", what did you have difficulty with?_____
   _____
   If "YES", did you get help and in what form was this help?_____
   _____

6. Rate the adequacy of the following Physics activities as : SATISFACTORY--(S), MARGINAL--(M), UNSATISFACTORY--(U), or DOES NOT APPLY--(NA)

(A) Laboratory experiments in P2204?____; in P3204?____;at MUN?____
(B) Classroom demonstrations in P2204?____; in P3204?____; at MUN?____
(C) Problem Solving in P2204?____; in P3204?____; at MUN?____
(D) Text materials in P2204?____; in P3204?____; at MUN?____
(E) Use of audio-visual materials in P2204?____;in P3204?____;at MUN?____

7. Do you feel that Physics courses you did in High School were adequate in preparing you for MUN Physics courses (YES or NO)?_____
If "NO", please explain why not._____
_____

8. What areas of the high school Physics courses do you think are weak and need upgrading?_____
_____

9. What areas of the high school Physics courses do you think are strong and should be kept as they are?_____
_____
Number and continue any of the comments:_____
_____

APPENDIX B

Summary of Teleconference of Physics Teachers in Newfoundland and Labrador Thursday, November 6, 1986

Robert Kelsey

The teleconference started with a sion on process chaired by Harvey Weir, Department of Physics Memorial University. He started the meeting by introducing Dr. Allan Griffiths, Head of the Department of Curriculum and Instruction of the Faculty of Education of Memorial University. He noted the break in communication between his department and Physics teachers through the medium of Physics Institutes which are no longer held. The discussion then led to the Science Council of Canada's "Report 36 Science for Every Student, Educating Canadians for Tomorrow's World." He mentioned the great deal of emphasis laid on the need for teaching our students about, 1)The role of Science and Physics amongst other sciences, in Canadian Society, 2) on the nature of Science itself and 3) the role of women in Science. He then discussed the extra year added to the high school in Newfoundland and went on to mention distinct changes in science education itself in Newfoundland. His major point here dealt with student misconceptions in Science and how we deal with these misconceptions as Science teachers.

Robert Kelsey, Physics Representative on the Newfoundland Teachers Association (N.T.A.) Science Council was then introduced. He discussed his role in the evaluation report of the Physics: A Human Endeavour program. He discussed the results of the Annual General

Meeting (A.G.M.) of the N.T.A. Science Council. The major focus of that meeting was that a resolution was to be made to the Department of Education to have the High School Physics program changed and that a pilot project should be initiated as soon as possible. Other points raised with respect to the A.G.M. in Corner Brook dealt with considerations that would help Physics teachers continue on with Physics: A Human Endeavour. These were as follows:

1. The editing of Physics 1200 and 1201 course tapes to help teachers with inadequate lab materials and expertise in introducing and explaining some of the more difficult areas of the High School Physics program.
2. The introduction of the computer in Physics courses. There was a need expressed for a software library or network that should be set up for communication of teachers ideas in this area.
3. Finally, the re-introduction of Physics Forum a high school Physics Newsletter that had ceased publication.

At this point, the teleconference was open for discussion to any teachers on the line. Some of the topics covered were:

1) Is there any consideration given to introducing a third physics course in the high school program. Many

topics in Physics are not covered in the present program that would be beneficial to students entering the trades like Power Engineering, etc.

2) Due to the fact that only three to five percent of students doing physics in high school go on to become physicists or have some kind of career in Physics does this mean that we are screening away a lot of students from doing Physics. If so, should we consider on cutting back on the difficulty of the present course.

3) In the past, there seemed to be more opportunity to get together for workshops to exchange ideas. Should we share information in this manner rather than the electronic means of communication.

4) If there are to be workshops some of the boards are not willing to support teachers in attending these workshops. Would the Department be able to support teachers attending these sessions.

5) With respect to the video tapes, they should not be used to replace laboratory experiments, but should be used as a supplement to aid in the understanding of lab experiments.

Cecil Lake, Past-Physics Representative on the N.T.A. Science Council discussed the paper put together by the Committee (Cecil Lake and Robert Kelsey) that was presented to Harry Elliott, Science Consultant, Department of Education, Newfoundland at the A.G.M. in Corner Brook. The survey viewed students at Memorial University, Sir Wilfred Grenfell College, Marine Institute and Cabot Institute. The survey looked into their comments relating to what they felt their education in Physics was at the high school level. It was found that the text content was generally satisfactory since it corresponded to material being introduced at the post-secondary institutions in physics. However, one of the major concerns was that the high school physics course had not prepared them adequately in terms of laboratory situations which they had to meet in the post secondary institutions. From the survey the committee found that most of the students taking Physics were of a higher academic ability and had better than average success in passing the high school program. Students overall seemed to feel they were prepared to enter the post secondary institution and take the first year course in Physics. They did think more laboratory time with problem solving situations was necessary.

In looking at the comments from instructors in post secondary institutions, the committee found that students were not prepared to handle the three hour lab. The areas of concern were ability to manipulate apparatus and problem solving. With respect to problem solving, distress was found with the mathematical capability of the student. It was their opinion that students should be performing more labs. This would familiarize them with handling experimental apparatus and the problem solving.

Mr. Bob Bishop, Department of Physics at Memorial University commented on the Committee's report. His view was that the report was a comparison of Physics programs in high school to Post-Secondary Institutions. He noted that students generally felt that the High School program adequately prepared them for university. He emphasized that the university labs are more structured and longer in length. The depth of treatment and problem solving are areas of concern. Although the topics in high school correspond to those covered in the first year university courses students do not appreciate the depth of treatment or the pace until it is usually too late. In looking at the problem solving in university and comparing it to high school. If a new course is to be developed timing will be a major

concern. The reason for this is because if students are to study kinematics then it requires a fairly good understanding of the solving of simultaneous equations by substitution and a good knowledge of the quadratic equations. Maybe at the Grade 10 level this would be difficult to do until a year later where a spiral type of approach could be used. This would mean a conceptual development in the beginning and probably spiral back with a more mathematical approach. Problems again arise for example in the area of electricity and magnetism where a three dimensional system is necessary. He finds that even students in University have trouble in this area. In concluding, his view is that the high school program should emphasize the development and application of concepts and definitions. Students need to know the fundamentals before sound problem solving strategies can be developed.

Mr. Basil Walsh, Department of Physics at the Lahot Institute of Technology, was next to express the concerns of this post-secondary organization. He started his discussion with agreement with the points made by Bob Bishop. His first point was one concerning basic skills of arithmetic and he wondered whether this could be corrected by a curriculum. His view on the high school lab was that it was weak. He thought

students need to be taught techniques more than experiments. His view of physics concepts was that a level of mental maturity needs to be reached before one could teach Newton's Laws for example to some depth.

The teleconference was now open for comments from teachers and the following are some of the comments and questions:

1) The labs in the schools in our district are ill equipped to teach physics or any science. The Department of Education needs to ensure that when introducing a new program that equipment be supplied.

2) When you talk about the three to five percent of physics students that go on to have careers in physics, we can not forget those students that will major in Biology, Chemistry, etc.

3) Problem solving in Physics is not unique as Math and Chemistry teachers have been saying the same thing.

4) If more depth is to be given to topics in terms of time what topics are going to be left out?

5) Are there a lot of students out there that are not doing Physics because of the level of difficulty of Physics 2204?

6) Besides the turn off of students due to the level of difficulty, as a teacher I find it a big turn off to teach it to beginning students of Physics. When I know there are many more interesting ways to introduce Physics to students. Its one of the serious difficulties I see with the present program.

7) I give many labs in Physics 2204 and overcome the difficulty problem in that way. It seems to generate enthusiasm.

8) If physics is being introduced in a school, where there are inadequate lab activities and inexperienced teachers that teach the course; it is not surprising that students do not continue with any further study in Physics.

9) One method of simplifying the physics is to co-ordinate the mathematics so that they correspond and supplement each other.

10) Should we as teachers be expending so much energy on the introduction of Motion, when there are more interesting ways to introduce Physics to our students?

11) Lowering the mathematical level of the course will not make the course more available to students. The concepts are difficult and will be difficult for the average student. What will happen is that your better student will end up with just a lower mathematical background.

12) The average student should be able to do the physics program and the mathematics will have to be taught as needed.

13) Perhaps the motion topic should be taught in the Level III course. This would give the students another year of Mathematics and correspond with the first year Physics course.

14) The spending of a full period in pre-preparation for a lab allows students to do the lab in the forty minute period. However, on the other hand students probably benefit more by sorting through the lab themselves rather than have it told

to them or set up for them ahead of time.

15) When doing the labs are the students given enough time to play around with the materials so that they understand what is happening and not to just finish it in one period to please the teacher.

16) In cases where there are forty minute lab periods do the students loose the continuity of the lab if they have to complete it the next day?

17) Should there be double periods for students doing physics, that is two forty minute periods back to back?

18) Concerning the video tapes, how might these be used by teachers having a weak background in physics or coming from poorly equipped schools. If this is the case can the Physics committee use this information to obtain more funding for the schools.

19) In the present program, Physics: A Human Endeavour, which is supposed to be a hands-on discovery approach to learning Physics. What has happened due to lack of facilities, poor Math skills and time constraints in the Level III course

is that the lab time has been cut back to one fifth the time the student is in class. In some cases it might even be less than one fifth. Maybe Physics teachers need flexibility in the scheduling to have double lab periods. Perhaps there should be a blanket statement by the Department of Education or some other source that would ensure that only level II's and III's be permitted to take the Physics. The reason being that the level I students would have an opportunity to pick up another year of mathematics. This would alleviate some of the problems of mixed ability math students in the physics program.

20) In regards to the grading of the labs and the time spent doing labs, how much of the evaluation should they be worth? At one period a lot of time was spent doing labs, but my marks used to be high with respect to the D factor in the province. I didn't want my students penalized for this, so I cut back on the marks for the labs and therefore had to cut back in the amount of time doing them.

21) It was mentioned earlier that we have added an extra year to the high school program. Actually, we have made the Physics program three years

shorter because of public exams being moved from the end of the year into June. This makes it difficult for students doing the Level III course who haven't done the second level course. Therefore, Chapter 13 is left out which is important to the understanding of the Nature of Light and Sound module. A lot of these problems being talked about might be overcome if we throw away Physics: A Human Endeavour and get a better course outline and a better text.

Mr. Frank Shapleigh, Gander, opened with the comment that there was certainly a need for a change, just as change was required twelve years ago. In order for change to take place it is necessary to look at the pros and cons of the present course. The pros are: It is good to have a developmental theme in Physics. The historical approach is good for topics. The methods of deriving algebraic formula and graphing are important, particularly if you look at the past and the Modern Physics course equations seemed to arrive on the scene out of thin air. The students were taught how to use them and were not given the opportunity to understand and derive them.

Conversely, the program is over ten years old.

There should be some mechanism in place where by these texts are reviewed every so many years. First, there should be more material dealing with modern topics in Physics, for example, Chernobyl. How many students know anything about nuclear reactors. Secondly, some of the material in the existing core program should be enriched. I do not think we are teaching as much Physics as was taught years ago. Perhaps some material can be deleted in favour of a better core program. The course description should be changed and as a result a new text could be brought into the high school. The scope of the topics in the present text end in 1905. Consequently, I think reevaluation of the program is necessary.

Teachers' comments and questions were now requested and they included the following:

1) There are other books available that cover the topics of Human Endeavour and follow a similar approach but are more up to date, more readable and do not have the errors in them like Human Endeavour.

2) I think the decision for a new course has already been made through the past discussion. The

decisions to be made now are:

a) What type of program is needed in the Newfoundland schools?

b) Can one Physics course meet the needs of students in the present school system?

c) What will be the course outline?

d) Will financial input from the Department of Education be adequate to meet the needs of the new program?

3) It is my experience for about ten years that there is such a wide diversity of backgrounds both in mathematical ability and the intellectual ability of students. In order to equip students for the physics they need when they get out into the real world and the physics necessary for job training either at the University or at other post secondary institutions, one Physics course may not meet the needs of all these students.

4) The last time we selected a new physics program there really was not a good set of course objectives put together first. We adopted a text. We should use the other route this time. We should sit down and decide what our course objectives are first, make sure they are very clear in our minds

and then see if we can find a text to meet those objectives.

5) Speaking of objectives for the new course, I think the objectives in the Searching for Structure 7,8 and 9 might be considered when looking for the format of the objectives in the new Physics program.

6) Some courses in the new reorganized high schools have been implemented after a six month pilot as one teacher I would want a course to be piloted for the proper length of time, two years at the minimum then evaluate it and have suggestions made.

7) Can a case be made for more than one pilot should there be more than one attractive alternative to meet the objectives set down by the Committee?

Mr. Harry Elliott, Science Consultant, Department of Education, Government of Newfoundland and Labrador said: "I certainly think we are not restricted to one pilot. The procedure normally followed in the development of a new program is for the working group to

be set up. This group writes a set of objectives. The objectives are specified first then the publishing companies are approached and asked if they have textbooks that match reasonably the course objectives. When the books are received the work groups will screen the textbooks and a decision is made to select one, two or more of these books in a number of schools. This pilot is conducted over a one or two year period, evaluated using a number of methods and then the textbook that is considered the best and correlates with the objectives specified is then implemented in the system."

The Science Consultant's view of the course was that it was reasonably good for the late seventies and the early eighties. The Physics course is the oldest unchanged Science course in the Science education system. He believed that many schools were ill-equipped to offer a strong lab component. His understanding of the lab component based on discussion was that the lab component was being de-emphasized for several reasons.

It is his view that at this time there is a need for a change. However, a reasonable approach must be used in changing texts. It is time to sit down and develop a new program. There are several publishers out

there in the process of developing new and additional physics texts. If a formal presentation is made to the Department of Education, he would support the efforts of the committee in trying to improve the Physics program in the province.

The teleconference was closed at this point. There was a request for teachers to complete the attached questionnaire. From the analysis of the questionnaire it was found that 88% of the teachers had made the following choice: "4. The Department of Education should set up a Physics Curriculum Committee to re-examine the whole course, and evaluate alternate text materials for possible piloting and future adoption".

TELECONFERENCE OF PHYSICS TEACHERS IN NEWFOUNDLAND AND LABRADOR

THURSDAY, NOVEMBER 6, 1986 AT 4:00 PM (ISLAND TIME)

LOCATIONS: Your nearest MUN Teleconference Center

(See attached list)

AGENDA

3:45-4:00 PM	Each center is signed on to the network. Ensure that your Center is turned on as soon as possible after you arrive (after 3:45 PM)
4:00-4:10 PM	Complete sign-on process, and explain teleconference procedures .... Harvey Weir "Brief" Greetings from Memorial University .... Dr. Allan Griffiths
4:10-4:15 PM	"Brief" Greetings from NTA Physics Committee and Synopsis of Physics Meetings at the NTA Science Council Conference .... Mr. Robert Kelsey, chairperson of Physics Committee
4:15-4:25 PM	Open for questions and comments
4:25-4:35 PM	What do Students at Post-Secondary Institutes Think of Their High School Physics Education? .... Mr. Cecil Lake, Corner Brook
4:35-4:45 PM	Response from Post-Secondary Institutions Mr. Bob Bishop, Memorial University Mr. Basil Walsh, Cabot Institute of Technology
4:45-4:55 PM	Open for questions and comments
4:55-5:00 PM	Can Labs be Done in 40 Minute Periods? .... Mr. Fred Shaw, St. Anthony
5:00-5:10 PM	Open for questions and comments
5:10-5:15 PM	Is it Time We Tried Something New? .... Mr. Frank Shapleigh, Gander
5:15-5:25 PM	Open for questions and comments
5:25-5:30 PM	Closing remarks .... Dr. Harry Elliott

October 20, 1986

To: Physics Teachers in Newfoundland and Labrador

From: Harvey Weir
Department of Physics
Memorial University

During the past few months I have "chatted" with several Physics Teachers about physics teaching. Most suggested that there is a need to increase contact and discussion with other physics teachers in the province, and it was felt that a province-wide teleconference of physics teachers would be a good idea. As a follow-up I contacted Mr. Cecil Lake of the NTA Physics Committee, Dr. Harry Elliott of the Provincial Department of Education, Dr. Allan Griffiths of MUN's Department of Curriculum and Instruction and Dr. David Rendell of MUN's Department of Physics for their support. This TELECONFERENCE is being arranged with them as one means of improving communications among our province's Physics Teachers and various other leaders in Physics Education.

The teleconference is scheduled to begin 4:00 PM and end at 5:30 on Thursday, November 6, 1986. You are asked to take five minutes or so at the end of the session to complete and return the enclosed questionnaire. The AGENDA, on the opposite page, gives roughly equal time to presentations and to open discussions and responses to these presentations. If you feel that more discussion time should have been

included, please note this as a major consideration in planning possible future teleconferences; also please identify topics for such teleconferences that are particularly important to you.

Enclosed is a list of Memorial University's Teleconference Centers. Many of you have done courses by means of this system, and are thus familiar with the location and operation of the local teleconference facility. Each center has a Coordinator, in most cases an employee of a local education or health facility. If you have any doubts about the location, availability or operation of your nearest center please contact the local Coordinator, as identified on the enclosed list, no later than November 5. The back page of this memo contains suggestions for the smooth running of a "tele" conference.

I realize that not every Physics Teacher lives or works within a reasonable after-school travelling distance of the nearest Memorial University Teleconference center. Even if you cannot participate on line, I would like for you to place your name, address, and school physics information on the enclosed questionnaire and return it to me. A transcript of the proceedings and notices of any such future meetings will be sent to all physics teachers returning this questionnaire.

SUGGESTIONS FOR TELECONFERENCE

1. Be available in the Center for signing on as soon as possibl after it is free (after 3:45 PM for this teleconference).
2. If possible, read over the agenda and background letter prio to the teleconference.
3. Identify yourself by name and place when making comment online. Other participants find it disconcerting not to kno who is talking or where they are from.
4. When there are a number of participants attempting to mak presentations, it is important that each keep his or he comments as brief as possible, without loss of the essentia idea.
5. Each center with more than a couple of participants shoul select one to act as a local chairperson for the proceedings In some cases, such a chairperson can act as a spokesperso for the group.
6. Additional comments can be included in the transcript of th teleconference by writing them on the back of the enclose questionnaire, and returning them after the conference. Thu even if you don't feel like making such comments on-line yo can still have a say.
7. If you get cut-off or run into technical problems during th conference, check with the local Teleconference Coordinator If he or she is not available, please call 737-6654 (collect and ask for the teleconference operator.

PHYSICS TEACHER/TELECONFERENCE PARTICIPANT QUESTIONAIRE

NAME:

TEACHING P2204___ P3204___ BOARD COORDINATOR___ OTHER

SCHOOL:

SCHOOL ADDRESS
(or alternate
mailing address) POSTAL CODE

FOR HIGH SCHOOL PHYSICS TEACHERS:

ESTIMATE TOTAL SCHOOL ENROLLMENT GRADES X XI XII

ESTIMATE OF TOTAL ENROLLMENT IN PHYSICS 2204 3204

ARE YOU YOUR SCHOOL'S ONLY PHYSICS TEACHER? YES NO

THE FOLLOWING QUESTIONS ARISE FROM REQUESTS FOR PHYSICS VIDEOTAPES:

USING "ADEQUATE", "MARGINAL", OR "NOT AT ALL", HOW WELL IS YOUR SCHOOL EQUIPPED FOR LABORATORY WORK?
IN P2204 IN P3204

HOW WELL IS YOUR SCHOOL EQUIPPED FOR PHYSICAL DEMONSTRATIONS AS PART OF YOUR LECTURES OR LESSONS?
IN P2204 IN P3204

TIME FOR PHYSICS?_____ PERIODS OF MIN EACH EVERY DAYS

DOES YOUR SCHOOL HAVE A VCR? YES___ NO___ (BETA? OR VHS?)

DO YOU HAVE A HOME VCR? YES NO (BETA? OR VHS?)

IF YOU OR YOUR SCHOOL HAVE A VCR, WHAT TYPE OF PHYSICS VIDEO TAPES (IF ANY WOULD YOU LIKE TO HAVE)?

WOULD NOT MAKE USE OF SUCH VIDEOTAPES

TAPES FOR TEACHERS VIEWING SHOWING HOW LAB EXPERIMENTS ARE DONE

TAPES OF LABOPATORY EXPERIMENTS FOR STUDENT VIEWING

TAPES OF PHYSICS DEMONSTRATIONS FOR STUDENT VIEWING

TAPES ON PROBLEM SOLVING FOR STUDENT VIEWING

OTHER (SPECIFY)

LIST SPECIFIC TOPICS YOU WOULD LIKE TO HAVE VIDEO TAPES ON :

WHICH OF THE FOLLOWING BEST EXPRESSES YOUR OPINION OF THE PRESENT HIGH SCHOOL PHYSICS TEXT BOOKS? (CIRCLE ONE OF THESE CHOICES)

1. We have had them for more than ten years and should keep them for at least another ten years.
2. We should keep using them until something better comes along.
3. I have found something better and believe it is time for a change.
4. The Department of Education should set up a Physics Curriculum Committee to re-examine the whole course, and evaluate alternate text materials for possible piloting and future adoption.
5. Other (Please specify):

ALL PARTICIPANTS ARE ASKED TO PLEASE RATE THE NOVEMBER 6 TELECONFERENCE using S for satisfactory or useful, B for borderline, U for unsatisfactory, or of little or no use.

1. The idea of a teleconference for Physics Teachers .
2. The presentations overall .
3. The time available for discussion .
4. The teleconference agenda .
5. The presentation and discussion on topic of STUDENT VIEWS .
6. The presentation and discussion on topic of LABS .
7. The presentation and discussion on topic of TIME FOR CHANGE .
8. The overall handling of the teleconference .
9. Proposal for further teleconferences for Physics Teachers .

SUGGESTIONS FOR FUTURE TELECONFERENCES:

PLEASE USE BACK OF QUESTIONNAIRE FOR ADDITIONAL COMMENTS, INCLUDING ANY THAT YOU WOULD LIKE TO HAVE PRINTED IN THE REPORT OF THIS CONFERENCE.

APPENDIX C

14 Hawker Crescent
St. John's, NF
A1E 3W4

Director of Education
Dr. Brown
Dept. of Education
Confederation Building
St. John's, NF

Sir:

I am the chairman of the Physics Branch of the N.T.A. Science Council. During the previous year, I have worked on a study to determine the quality or merit of the present High School Physics program. (Physics: A Human Endeavour). This study was written by the past chairman Cecil Lake, Corner Brook and Robert Kelsey in St. John's. The request for the study arose from an overwhelming desire of teachers at the 1985 Science Council meeting in Gander, to evaluate the prewent program. The majority of Physics teachers present felt that there were several problems with the program and that a motion be made to look at the possibility of obtaining a new program.

During the past year, since the meeting, Cecil Lake and I have worked on a paper evaluating the present text. Although the information obtained was statistically significant. It was found that the information overwhelming pointed to the need for a new program. This report is enclosed with this letter, please note the recommendations of this paper.

In October 1986 at the Science Convention in Corner Brook, Cecil Lake and I presented our report to the Physics teachers at the conference. The teachers were not at all surprised by our results. However, we were able to have all of the Physics teachers present agree that a request be made for a new Physics program. During this convention I was nominated and subsequently elected chairman of the Physics Branch of the Science Council.

Prior to the convention, I had been in contact with Harvey Weir in the Physics Department of Memorial University and discussed some of the findings of our report. He suggested a teleconference to be held two weeks after the convention, that would include all areas of Newfoundland and Labrador. I was excited about the idea and we sent a questionnaire to all the schools in Newfoundland and Labrador that taught Levels I, II and III. This questionnaire included an invitation to participate in the teleconference. It also included an evaluation of the present Physics program. The result of this questionnaire by Physics teachers to date was 88% for choice four on our questionnaire that stated "4. The Department of Education should set up a Physics Curriculum Committee to re-examine the whole course and evaluate alternate text materials for possible piloting and future adoption." 10% chose choice two that stated "2. We should keep using them until something better comes along." Finally, there were 2% that chose #5 which was "Other" and the comment made was "Changing to a new text every 2 - 4 years as advanced Physics education continues". These results illustrate an overwhelming demand for a change. Although I can not give you a complete summary of the questionnaire at this time, I can supply you with an audio tape of the Physics teleconference. If more information is needed feel free to contact me and I would be pleased to answer your questions.

As chairman of the Physics branch of the Science Council, I request that you, as the representative of the Department of Education, set up a Physics Curriculum Committee to re-examine the whole course, and evaluate alternate text materials for possible piloting and future adoption. A committee should be selected as soon as possible. It should develop course objective and goals. After this it should recommend texts that could be piloted in the Fall of 1987. This should all be completed prior to the Easter vacation of 1987. The reason for this is to get materials out to the piloting teachers before the end of the school year, thus, allowing them adequate time to prepare for the new

program over the summer. I appreciate any effort you may exert on our behalf. I look forward to hearing from you with your response to our request.

Respectfully yours,

Robert Kelsey
Chairman Physics Branch
N.T.A. Science Council

School Address:

Holy Spirit School
Powerscourt
Manuels, NF
A0A 2Y0

APPENDIX D

Government of Newfoundland and Labrador
Department of Education

P.O. Box 4750
St. John's, NF
A1C 5T7

February 23, 1987

Mr. Robert Kelsey
Chairman, Physics Branch
NTA Science Council
C/O Holy Spirit School
Powerscourt, Manuels
Newfoundland
A0A 2Y0

Dear Mr. Kelsey:

I am writing in reply to your recent letter concerning the high school Physics program.

I have discussed the question of Physics renovation with Mr. Elliott, as this is the next Science program due for review. However, funds for committee work for the 1986-87 year have been fully committed. Our plan at the present time is to establish a Physics Committee to begin work in the fall of 1987.

In the course of the program revision, we would appreciate any advice that the Science Council would be able to give us.

Yours truly,

C. K. Brown
Director of Instruction

CKB:js
cc: Mr. H. Elliott

APPENDIX F

Department of Education

Province of Newfoundland and Labrador

SUMMARY OF OUR EDUCATION SYSTEM

The province of Newfoundland and Labrador has a Denominational Education System. Under this arrangement, responsibility for education is shared between the Provincial Government through the Department of Education and the major Christian Churches through the Denominational Education Councils. There are three such councils: the Roman Catholic Education Council; the Integrated Education Council which comprises Anglican, Moravian, Presbyterian, Salvation Army and United Church; and the Pentecostal Assemblies Education Council.

The Seventh Day Adventist also operates a school system, but has relatively few students and is not part of the Denominational Education Council Arrangement.

The Government's Role

The basic responsibility of the Government is to see that the Province offers the best possible educational services, designed to meet the needs of all students. This responsibility is discharged through the following means:

(1) The enactment of laws and regulations governing the operation of schools. This legal framework provides for, among many other things, the establishment of school boards and the delegation of responsibilities to them, the certification of teachers, the allocation of teachers to boards, and the funding of different educational programs.

(2) The development and prescription of basic courses of study. The content of each course at each grade level is specified to ensure that students receive the proper sequence of learning experiences as they progress through their grades. In most subjects, textbooks are prescribed and supplied to school boards free of cost or at a subsidized rate.

(3) The establishment and maintenance of minimum standards for education in our schools. This is done through such measures as the certification of teachers and the testing and evaluation of pupils, including a shared method of evaluation at the end of high school. There are also strict health and safety standards governing the provision of all school buildings.

(4) The financing of education by making payments to school boards and, in the case of school construction, to the Denominational Education Councils. Altogether, the Government pays directly for about 95 percent of the cost of elementary-secondary education. The remaining five percent is raised locally through school taxes and assessments.

The Church's Role

The Churches are represented in the educational system through their particular Denominational Education Council. The role of these Councils include:

(1) Determining how and where money will be spent for new school buildings, extensions and equipment.

(2) Recommending to government the establishment and alteration of School District boundaries.

(3) Recommending to Government the appointment of school board members.

(4) Recommending the initial certification of teachers.

(5) Developing and prescribing Religious Education Programs.

School Boards

There are 35 school boards throughout the province to administer all matters pertaining to the day-to-day operations of schools. School boards are, therefore, responsible for such things as the organization of schools within their districts, the fixing of attendance zones, the repair and maintenance of school buildings, the employment of teachers and other staff and arranging for pupil transportation.

Under The Schools Act, at least two-thirds of the members of each school board must be elected by popular vote. School Board elections are held every four years and coincide with Municipal Council elections. Every school board meeting, unless it is held as a privileged meeting, is open to the general public. Through participation in the election process, and attendance at meetings, the general public can make a contribution to education and can have an effect on educational decisions made at the community level.

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